Article

Awareness of alternative gluten-free grains for individuals with coealiac disease

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Abstract

Purpose: Coeliac disease (CD) is a prevalent autoimmune disorder, affecting 1 in 100 of all individuals in the UK. Currently, the only treatment for CD is complete avoidance of gluten, a protein commonly found in wheat, rye and barley. The use of alternative grains (AG) is highly recommended to individuals with CD to improve and diversify their diet. This study aims to determine the current knowledge of the gluten free diet (GFD), consumption rates of AG and awareness of AG, for individuals diagnosed with CD.

Methodology: A total of 100 participants were recruited via local coeliac support groups as well as an 'Allergy and Free From Show', to participate in a survey. Consent was obtained from all organisations and all individual participants, prior to collecting data. The questionnaire consists of 10 questions, related to participants' demographic characteristics, knowledge of gluten free food (GFF) and AG and consumption rate of AG. Chi-Square (χ^2) analyses were conducted to compare the variables between gender and time of diagnosis.

Findings: Overall, both genders possessed good knowledge of the GFD. Yogurt, vinegar and oats resulted in the highest incorrect responses. It was found that females possesed better knowledge of both GFF and AG. Rice, quinoa and corn were amongst the most popular AG consumed whilst Job's tears, fonio and sorghum were the least consumed grains. Females reported a higher consumption rate of AG than males. Additionally, those more recently diagnosed had poorer knowledge of the GFD, reduced consumption rates of AG and poor awareness of AG.

Originality: It can be suggested that the incorporation of AG into the diet, can prove beneficial for coeliacs and that both knowledge and education, play a fundamental role in determining consumption rates amongst individuals.

Keywords: alternative grains; coeliac disease; diagnosis; gluten free; nutrition

Introduction

Coeliac disease (CD) has now developed into a prevalent autoimmune disorder, affecting 1 in 100 of all individuals in the UK (Ciacci et al., 2015). The increased incidence of this chronic inflammatory disease is a growing concern, having increased in fourfold over the last two decades (West et al., 2014). Though initially thought to exist exclusively in European

countries, CD is now regarded as one of the most common genetic diseases, with a 0.9% prevalence worldwide (Lionetti et al., 2015).

CD is developed when gluten, a protein matrix formed by gliadin and glutenin commonly found in wheat, rye and barley is consumed by genetically predisposed individuals, causing damage to the lining of their small intestine. Patients diagnosed with CD possess villous atrophy (flattening of the villi) and crypt hyperplasia (elongated crypts between villi), leading to a reduced absorption of essential nutrients and consequently malnutrition (Fei et al., 2012; Green et al., 2015). Following gluten ingestion, individuals with CD will exhibit several short-term and long-term consequences, which differ in both time (certain symptoms will disappear in hours, while others may persist for weeks) and severity (ranging from barely noticeable to extreme discomfort) (Pulido et al., 2013). Common gastrointestinal symptoms associated with this enteropathy include abdominal discomfort, altered bowel habits, severe diarrhoea and heartburn (Castillo et al., 2015). Whilst destruction of the gut is a major component of the illness that is CD, the issues unfortunately do not stop there. This systematic disease can also have a detrimental effect on many vital organs, such as the heart, skin, liver and brain (Moreno et al., 2014). Examples of extraintestinal manifestations include anaemia, osteoporosis, liver abnormalities and dermatitis herpetiformis (a skin manifestation of CD) (Leffler et al., 2015). This vast array of inevitable symptoms that are associated with this autoimmune disorder, places a heavy burden on any individual with CD.

Currently, the only proven treatment for CD is avoidance of all gluten containing products. Adherence to this strict diet allows the gut to heal and efficiently absorb nutrients, thus reducing any long-term consequences associated with CD (Jnawali et al., 2016). With 38% of individuals who removed gluten from their diet, showing an immediate improvement in overall health, the positive influence of the gluten free diet (GFD) is clearly illustrated (Gaillard, 2016). In fact, strictly adhering to the GFD has been shown to decrease long-term health risks, such as gastrointestinal malignancies, osteoporosis and anaemia. Moreover, improvement in overall quality of life and consequently psychological wellbeing is a noticeable benefit, for those adhering to the GFD (Hall et al., 2009). Whilst the positive influence of the GFD is clearly illustrated, it is important to note that there are many cases of refractory CD, which unfortunately do not respond to the GFD. In fact Gaillard (2016), found that only 38% of individuals who removed gluten from their diet, showed an immediate improvement in overall health, with all other individuals experiencing persistent symptoms of CD and continual villous atrophy. This is further reinforced by Paarlahti et al.

(2013), who found that 25% of individuals continued to suffer from the persistent symptoms of CD, despite committing to a strict GFD. Furthermore, complete compliance to the severely stringent regime that is the GFD, requires constant vigilance and therefore can prove to be much harder than originally thought. Gluten features as a prominent protein in countless foods, including pasta, bread, cereals and confectionary. Gluten has unique structural and functional properties and is known to provide visco-elasticity, taste, texture, ability to bind fat and water, consequently proving gluten as an essential component of many foods (Day et al., 2016). Therefore, with gluten dominating the food industry, it is no surprise why complete avoidance of this persistent protein, is challenging (Makharia, 2014). Hidden sources of gluten can prove to present an additional challenge. . For example, sauces and marinades, processed meats, soups and alcohol, though in minimal amounts, may still contain gluten and thus extra care should be taken when consuming these foods (Lebwohl et al., 2015). Whilst it is common knowledge, that those with CD should avoid all wheat based food products, it is also important to remember that gluten is frequently added to many inconspicuous foods It is clear that gluten free food (GFF) are a necessity, in order to accommodate for the millions of people, who are currently eliminating this life threatening protein from their diet.

Alternative grain sources to the GFD (including cereals, minor cereals and pseudocereals), can be categorised under three key grains; cereals (rice, corn and sorghum), minor cereals (fonio, teff, millet and job's tears) and pseudocereals (buckwheat, quinoa and amaranth). All are rich in a variety of nutrients, minerals, phytochemicals and dietary fibre and therefore, their consumption has been widely recommended to all individuals (Li et al., 2016). Furthermore, all AG are lacking in gluten, an essential component for coeliacs, thus providing an additional benefit for those with CD. Whilst whole grains are a means of improving the quality of diet, the consequent improvement in quality of life is perhaps the true benefit for coeliacs. Therefore, the use of these alternative grains (AG) is highly recommended to individuals with CD (Comino et al., 2013). Despite this, coeliacs are known to have a low consumption rate of AG. Despite knowing the many benefits of AG, consumption rates amongst coeliacs and non-coeliacs are low and rapidly declining (Nicklas et al., 2013: Mann et al., 2015). The increased expense of grain products, or the preferred convenience of buying readily prepared foods containing refined grains, as opposed to buying and preparing raw grains, may attribute to this damaging consequence (Nicklas et al., 2013).

Whilst finance and convenience are both influential factors of current diet status for coeliacs and non-coeliacs, research indicates that lack of knowledge is perhaps the most detrimental influencer. Many individuals with CD possess an ingrained belief that all grains contain gluten and this ignorance and fear of contamination is causing reluctance amongst coeliacs, ultimately leading to reduced whole grain consumption (Kmietowicz, 2017). Furthermore, recent research indicates that elimination of grains from the diet, due to poor education, is associated with a range of health problems, specifically the increased incidence of heart attacks (Lebwohl et al., 2017). A further explanation for the reduced consumption rates of AG amongst coeliacs could be due to the distribution of vouchers, which allow individuals to purchase GFF at a discounted price. This particular strategy is utilised in many countries including the UK, to assist coeliacs in managing their condition. GFF are made available on prescription to patients with CD. In fact, 90% of patients with CD relied on prescriptions for GFF (Robins et al., 2008). However, this may prove to be more disadvantageous and detrimental to overall health, as offering coeliacs GFF at discounted prices, discourages the consumption of AG (Muhammad et al., 2017). This is an issue, as the consumption of AG, provides a clear alternative for coeliacs, which is both proven and tolerable. Thus, this study aims to determine the knowledge of individuals diagnosed with CD, on their current knowledge of the GFD, their consumption rates of AG and awareness of AG that could positively influence their health status.

Materials and methods

Subject recruitment

This particular research targeted both male and female individuals of ≥ 18 years old, who were diagnosed with CD (Table 1). A total of 100 participants were recuited to take part in this study. Previous study looking into a similar area of research recruited 50 participants and found that the use of AG was more beneficial in improving the nutritional profile of individuals with CD (Lee et al., 2009). This coupled with the time restraints and the participation of an extremely targeted population (individuals diagnosed with CD), indicates that a minimum of 100 participants is sufficient. Participants were recruited via local coeliac support groups, as well as an 'Allergy and Free From Show'. Whilst attending the show, additional support groups such as Coeliac UK and Allergy Awareness were approached, to recruit further participants. Consent was obtained from all organisations and all individual participants, prior to collecting data. The study was approved by the University ethics committee prior to subject recruitment.

Questionnaire development

The questionnaire was composed of 10 short questions, related to participants' demographic characteristics (7 questions), knowledge of GFF and AG (2 questions with sub-choices) and consumption rate of AG (1 question with sub-choices). Participants were asked to select correct GFF from a checklist. All 15 food items were compared with the Coeliac UK Gluten Free (GF) Checklist (Coeliac UK, 2018), to positively determine which items were GF. To test the awareness of AG participants were asked to identify if it was possible for three different GF grains (amaranth, quinoa and buckwheat), to be used in the production of six generic food items (chocolate cake, vegetable soup, tomato pasta, porridge, blueberry muffins and rice pudding). Description and photos of the grains were included in the survey for participants who may not have heard of the AG. Based on Haros and Sanz-Penella (2017), all three types of grains can be utilised to make the six food items. The questionnaire given to all participants was adapted from others used in similar studies (Simpson et al., 2011; Silvester et al., 2016). A pilot test was also conducted with 10 CD patients, prior to collecting main data, to assess the feasibility, clarity and time taken to complete the questionnaire. After completion of the pilot study, slight modifications were made to the questionnaire. The number of questions was reduced from 14 to 10, in an effort to allow participants to focus purely on their knowledge and awareness of AG.

Statistical analyses

Statistical analyses were conducted using IBM SPSS Statistics Version 23. A Chi-Square (χ^2) analysis was carried out, to test for a number of different variables.

Results and Discussion

A total of 100 participants (23 males and 77 females) completed the survey. All participants were diagnosed with CD (Table 1). The large gender difference within participants is plausible, as CD is more prevalent in women than men, with 60-70% of individuals diagnosed with CD being women (Shah and Leffler, 2010). The fact that women, on average, are more likely to use healthcare services than men, can also explain this (Pinkhasov et al., 2010). More than 60% of the participants reported that they adhered to strict GFD while slightly less than 20% follow GFD most of the time.

Insert Table 1 here

Knowledge of GFF and ingredients

Statistical analysis highlighted that of the fifteen different food items, there was a significant difference between males and females in five of the food items. These included semolina, vinegar, buckwheat, cocoa and eggs (Table 2). Both genders scored equally (100%) on three of the fifteen food items (milk, chicken and rye). Males scored 17% higher on one food item (oats), than females. Females scored higher on all other food items, indicating that overall, females possess an increased knowledge of the GFD. It is important to note, that adequate knowledge of the GFD is the key to successfully managing CD and that, this knowledge is essential for dietary compliance. Without sufficient knowledge, patients are at risk of accidental consumption of gluten and consequently continued villous atrophy (Ciacci et al., 2015). Overall, both genders possessed good knowledge of the GFD. This is justifiable, since most participants had been confirmed with CD through clinical diagnosis, as opposed to self-diagnosis. Hence, it can be assumed that patients would have received some form of information regarding their condition and management. This, coupled with the fact that all individuals were recruited at a place where they were actively seeking out information (i.e. "Allergy and Free From Show" and coeliac support groups), indicates that all participants should possess enough knowledge of GFF.

Insert Table 2 here

Furthermore, this study found that females had an increased knowledge of the GFD, than males and is consistent with previous research, which suggests that females have a higher adherence to the GFD, due to their increased knowledge (Leffler et al., 2008). Yoghurt produced the most incorrect responses by both genders. This could be due to misconception by participants and lack of specificity of the question ("Is yoghurt GF?"), as although plain yoghurt is considered to be GF, yoghurt which is flavoured or has added grains cannot be consumed by coeliacs (Coeliac UK, 2018). Oats produced the third most incorrect answers and was the only food item, whereby females scored lower than males. There has been much controversial evidence surrounding the addition of oats in the GFD. Whilst the consumption of pure oats has been deemed safe for consumption, oats contaminated with gluten are harmful (Fric et al., 2011). However, studies have reported that oats may be immunotoxic in patients with CD (Arentz-Hansen et al., 2004; Tuire et al., 2012). Among patients that reacted to oats, the abnormal immunological response against avenins may have been triggered by a similar mechanism to that of gluten (Comino et al., 2015). Other studies revealed that coeliac patients who consumed oats showed no signs of intestinal inflammation (Kaukinen et al., 2013; Lionetti et al., 2018). This demonstrates the

importance of ensuring the safety of oats (prevention of cross contamination with gluten containing cereals) and the need to identify oat varieties with no toxicity towards patients with CD (Comino et al., 2011).

Times of diagnosis may also affect the level of awareness of GFF. Results indicated that there was a significant difference in four of the food items. These included yoghurt (χ^2 (3) = 26.984, p = < 0.001), vinegar (χ^2 (3) = 29.779, p = < 0.001), buckwheat (χ^2 (3) = 7.827, p = < 0.05) and soy sauce (χ^2 (3) = 15.283, p < 0.05). In three of these food items (vinegar, buckwheat and soy sauce), it was found that those individuals diagnosed before 2003, had the highest percentage of correct answers. Additionally, for these three food items, those diagnosed in 2017 had the lowest percentage of correct answers. Patients diagnosed at an earlier stage (before 2003) had better knowledge than those diagnosed later. A difference does exist in adherence, between newly diagnosed individuals and those who have observed the GFD long-term and that this difference is due to lack of knowledge exhibited by newly diagnosed individuals (Ludviggson et al., 2014). In this case, it is recommended that at the time of diagnosis, individuals with CD should be referred to a registered dietitian and encouraged to join coeliac support groups, in order to attain this knowledge and consequently improve their nutritional profile (Ciacci et al., 2015).

Consumption of alternative grains

Participants were asked how often they consume AG on a weekly basis.

Table 3 highlights the % of grain consumption for both genders on a weekly basis. Job's tears, fonio and sorghum were the least consumed grains. Both amaranth and millet were consumed at a higher rate than the above three grains although their consumption were still relatively low. Quinoa and corn were relatively popular amongst both genders. Rice was the most popular grain, with all males consuming it at some point during the week and only a small population of females, not consuming it at all. Of the 10 grains, there was a significant difference between male and females in only one of the grains – buckwheat (χ^2 (2) = 9.105, p < 0.05). More than 90% of males reported never having consumed buckwheat while slightly more than 20% of females reported consuming buckwheat once per week.

Insert Table 3 here

Time of diagnosis revealed a significant difference in consumption rates of three types of grains. These were quinoa (χ^2 (6) = 10.467, p < 0.001), teff (χ^2 (6) = 46.490, p < 0.001) and millet (χ^2 (6) = 30.262, p < 0.001). This suggests that for these three grains, there was

a varied consumption rate amongst individuals diagnosed at different times, as opposed to all other grains, whereby consumption rates were similar, regardless of time of diagnosis. For individuals diagnosed in 2017, amaranth, sorghum, fonio and millet were not consumed at all. Individuals diagnosed prior to 2003 to 2016 did not consume job's tears.

Females reported a higher consumption rate than males and those diagnosed earlier were more inclined to consume AG, than those more recently diagnosed. This could simply be because, females and those diagnosed earlier, have an increased awareness of the nutrient deficient GFD and consequently possess better knowledge of the influence of AG (Leffler et al., 2008). Furthermore, the increased consumption rate of AG exhibited by females can also be explained by the fact that females, in general, are more interested in cooking as well as trying new foods and recipes, as opposed to males (FSA, 2014). For all participants, regardless of gender and time of diagnosis, rice was the most frequently consumed grain. Valitutti et al. (2017), who also found increased rice consumption in individuals with CD, supports this.

Overall AG consumption for all participants was quite low. This is consistent with previous research, which indicates that those from the coeliac community have low consumption rates of AG (Nicklas et al., 2013). Misconceptions, such as, believing a grain contains gluten when it is actually GF, could potentially play a role in explaining this low rate of consumption (Kmietowicz, 2017). However, for this particular study, the true reasons for the avoidance of AG is unknown (a limitation), and hence further research into this area could prove beneficial for health care professionals, as a means of educating the coeliac community, thus increasing adequate grain consumption and subsequently improving overall nutritional status (Valitutti et al., 2017).

Awareness of utilisation of AG in different food items

Overall, females had a higher percentage of correct responses for foods made with amaranth and buckwheat. In contrast, males had a higher percentage of correct responses for foods made with quinoa; however the difference was relatively small for most food items, suggesting that females have a higher awareness of AG. Additionally, both males and females had a higher incorrect response rate for blueberry muffins, in comparison to all other food items. Food uses of rice pudding were better known by males and females, with both genders producing a higher percentage of correct responses (Table 4).

Insert Table 4 here

Overall, it can be said that those diagnosed before 2003, have a much higher correct response rate than those diagnosed after this time, suggesting their increased awareness of AG (Table 5). All participants diagnosed in 2003, scored 78% or higher. In contrast, those who were more recently diagnosed (2017), had poorer awareness of AG, with all individuals diagnosed in 2017 producing the highest percentage of incorrect responses. Most individuals, regardless of time of diagnosis, were more aware of the food uses of quinoa, with participants having a high correct response rate for this grain.

Insert Table 5 here

Females had a greater awareness of AG in comparison to males. Additionally, newly diagnosed individuals had poorer awareness when compared to those diagnosed before 2003. This can again be explained by the fact that these individuals already possess an increased knowledge regarding the nutritional limitations of the GFD and as such have become aware of potential pseudocereals that could provide a healthy alternative (Leffler et al., 2008). Also, the increased awareness of AG exhibited by females can again be due to their increased likelihood of both cooking and trying new recipes, in comparison to males (FSA, 2014). Another explanation could be due to the increased commercialisation of these grains (Moreno et al., 2014). The prevalence of CD has greatly increased and hence further scrutiny has been placed on the GFD, steering coeliacs towards viable alternatives (Ciacci et al., 2015). This has warranted food industries to produce and advertise a range of GFF incorporated with these versatile grains. Hence, this global publicity has provided a means of education for coeliacs (Boukid et al., 2017).

Limitations

All participants were recruited via an 'Allergy and Free From Show' and coeliac support groups and thus may already possess a heightened awareness of the GFD and AG, when compared to other coeliacs. Moreover, participants' place of recruitment increases the likelihood of individuals having an interest in the study and being more positively motivated. Therefore, results may not be an accurate representation of the overall coeliac community. Furthermore, all data was collected via self-reported questions.

Conclusion

There is overwhelming evidence that the GFD is the only proven treatment for CD. However it can be challenging to adhere to and CD patients should ensure they consume a varied GFD to ensure they meet their nutritional requirements. This study found that females possesed better knowledge of both GFF and AG. Additionally, those more recently diagnosed had poorer knowledge of the GFD and AG and reduced consumption rates of AG.

Pseudocereals are alternative sources of grains that can be incorporated into the diet. Whilst incorporation of pseudocereals into the diet can provide an essential alternative for coeliacs, results from this study clearly implicate that grain consumption is far from adequate. It seems that knowledge plays a fundamental role in determining consumption rates of AG. Therefore, the need for sufficient education is not only recommended but is absolute necessary, to improve the current nutritional status, of those suffering from the chronic autoimmune disorder that is CD.

Recommendations for future research

To further improve the study, research into the current diet status of the participants can be beneficial in establishing if individuals are able to meet their daily nutritional requirements. Dietary status can also be utilised, to influence the incorporation of specific AG into the diet, if individuals are lacking in key nutrients. Additionally, an analysis into the reasons behind avoidance of certain grains, could prove beneficial in increasing consumption rates amongst coeliacs. Long-term follow up studies among adults with CD and the uptake of AG and GF sources rich in nutrients should be carried out. It is also recommended that further studies on the ignorance of AG and GFF be conducted as this can directly affect adherence to GFD.

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Table 1 Demographic characteristics of participants (n=100)

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Characteristics	%
Gender	
Male	23
Female	77
Age	
18 to 24	29
25 to 34	16
35 to 44	8
45 to 54	10
55 to 64	19
65 to 74	18
When were you diagnosed with coeliac disease?	
2017	28
2010 – 2016	20
2003 – 2009	11
< 2003	41
How have you been diagnosed with coeliac disease?	
Duodenal biopsy	59
Bloodwork	26
Gene testing	13
Self-diagnosis	2
Please describe your current diet.	
Unrestricted diet	1
Gluten free diet occasionally	10
Gluten free diet most of the time	18
Strict gluten free diet	61
Trying to follow a strict gluten free diet, but not always sure	10
How long have you restricted the amount of gluten in your diet?	
Less than or equal to 5 years	48
Between 6 – 10 years	5
11 – 15 years	12
16 – 20 years	19
More than 20 years	16
Do you avoid or restrict any other foods?	
Yes	44
No	56

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522 **Table 2** Knowledge of GFF and ingredients (n=100 and represents number of participants

523 who answered correctly)

Food Items	Is it gluten free?[a]	Males n (%)	Females n (%)	χ^2
Oats	✓	21 (91.3)	57 (74.0)	3.1
Milk	✓	23 (100)	77 (100)	NC
Chicken	✓	23 (100)	77 (100)	NC
Semolina	X	19 (82.6)	75 (97.4)	6.87*
Potatoes	✓	21 (91.3)	77 (100)	6.83

Yoghurt	✓	8 (34.8)	29 (37.7)	0.06
Rye	X	23 (100)	77 (100)	NC
Vinegar	X	21 (91.3)	52 (67.5)	5.08*
Buckwheat	✓	16 (69.6)	75 (97.4)	16.75*
Couscous	X	21 (91.3)	74 (96.1)	0.86
Cocoa	✓	19 (82.6)	75 (97.4)	6.87*
Soy Sauce	X	19 (82.6)	65 (84.4)	0.04
Tomatoes	✓	21 (91.3)	77 (100)	6.83
Quinoa	✓	22 (100)	77 (100)	3.38
Eggs	✓	20 (87.0)	77 (100)	10.35*

Note: [a] indicates the correct answers; NC – not computed as both males and females scored 100% (correct answers) for the particular food items; * denotes significant difference, $p < 0.05$

Table 3 Percentage of grain consumption on a weekly basis (n=100)

Grains	**Once/Week**		**3 Times/Week**		**Not at All**		χ^2
	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)	
Buckwheat	0	22.1	4.3	0	95.7	77.9	9.11*
Amaranth	17.4	11.7	0	0	82.6	88.3	0.51
Quinoa	65.2	49.4	8.7	16.9	26.1	33.8	1.96
Rice	60.9	53.2	39.1	45.5	0	1.3	0.65
Corn	65.2	54.5	17.4	31.2	17.4	14.3	1.67
Sorghum	0	11.7	4.3	2.6	95.7	85.7	3.07
Fonio	0	11.7	0	0	100	88.3	2.95
Teff	30.4	45.5	8.7	2.6	60.9	51.9	2.86
Millet	4.3	24.7	4.3	3.9	91.3	71.4	4.59
Jobs Tears	0	0	0	1.3	100	98.7	0.30

*significant difference at $p < 0.05$

Table 4 Awareness of utilisation of AG in different food items (n=100)

Grains	**Amaranth**			**Quinoa**			**Buckwheat**		
	Males (%)	Females (%)	χ^2	Males (%)	Females (%)	χ^2	Males (%)	Females (%)	χ^2
Chocolate cake	43.5	71.4	6.08*	47.8	61	1.27	43.5	80.5	12.05**
Vegetable soup	47.8	62.3	1.54	78.3	67.5	0.97	43.5	70.1	5.46*
Tomato pasta	43.5	58.4	1.60	73.9	75.3	0.02	39.1	63.6	4.37
Porridge	60.9	68.8	0.51	82.6	59.7	4.07*	56.5	74	2.58

Blueberry muffins	30.4	63.6	7.92*	78.3	66.2	1.1	21.7	75.3	21.82**
Rice pudding	73.9	72.7	0.01	91.3	76.6	2.39	56.5	66.2	0.73

533 *significant difference at $p < 0.05$; ** $p < 0.001$

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536 **Table 5** Time of diagnosis and awareness of utilisation of AG in food items (n=100)

Food Items	**Amaranth χ^2 (df)**	**Quinoa χ^2 (df)**	**Buckwheat χ^2 (df)**
Chocolate cake	χ^2 (3) = 7.809	χ^2 (3) = 18.806**	χ^2 (3) = 4.430
Vegetable soup	χ^2 (3) = 14.729*	χ^2 (3) = 12.988*	χ^2 (3) = 20.466**
Tomato pasta	χ^2 (3) = 18.331**	χ^2 (3) = 6.173	χ^2 (3) = 12.275*
Porridge	χ^2 (3) = 16.874*	χ^2 (3) = 32.764*	χ^2 (3) = 21.030*
Blueberry muffins	χ^2 (3) = 16.961*	χ^2 (3) = 12.142*	χ^2 (3) = 9.229*
Rice pudding	χ^2 (3) = 18.655**	χ^2 (3) = 14.437*	χ^2 (3) = 20.363**

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